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ABSTRACT

The field of cognitive science (as represented, for instance, by intergenerational literacy programs) offers new ways to think about increasing cognitive abilities, which is particularly important in view of the disappointing outcomes of many intervention programs that do not seem to make their participants more knowledgeable or better thinkers. Important to cognitive scientists are the beliefs that (1) development of cognitive ability continues throughout life; (2) the processes involved in cognition are as important as the end product or behavior; (3) knowledge and the processes used to operate on knowledge are inseparable so that abilities must be developed within the context of the types of situations and tasks to which one expects the knowledge to be applied; and (4) the individual's potential for intellectual growth and development is primarily determined by the social and cultural groups into which the person is born and raised. It should be possible almost to double the improvement of cognitive ability that present dollars accomplish. To do so, investment must be made in programs that focus on the intergenerational transfer of cognitive ability; the functional contexts of education; and the linking of problems, practice, and research over extended time. (The document includes a 91-item reference list and the table of contents of an upcoming book of papers prepared for the 1989 Conference on the Intergenerational Transfer of Cognitive Skills.) (CML)

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MAKING THE NATION SMARTER:

The Intergenerational Transfer of Cognitive Ability

by

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January 1989

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Executive Summary

Making the Nation Smarter: The Intergenerational Transfer of Cognitive Ability

Today there is widespread concern that the major tool for transmitting knowledge to new generations - the public schools- is failing. Numerous reports have noted that the dropout rate is high and among those who drop out, there is a low level of cognitive achievement. Even among those who graduate from high school, it is estimated that one in six may be "functionally illiterate." Low literacy levels are related to unemployment, welfare, and poverty. These problems are considered to contribute to low productivity in the workplace, as well, which is a large concern as the United States appears to be losing it's competitive edge in the world marketplace.

Education problems loom even larger as the future is considered. Demographic projections show that the population of youth is declining, except for minority groups, the very group that constitutes the largest percentage of dropouts, unemployed, and welfare and poverty groups. As this trend materializes, the future workforce will be comprised of people with lower cognitive skills. Predictions of work in the future show that while many jobs will be available in the lower-level, low-paying range, many jobs will be created in accordance with advances in new technologies. Fewer young adults will be available with cognitive ability needed to keep the U.S. competitive in the marketplace and there will be an ever-widening gap between the haves and the have-nots.

In the face of these educational and demographic trends, there have been widespread calls for education reforms, lifelong learning, retraining of workers, and, in general, a concern for **making the nation smarter.**

Past Attempts at Educational Interventions

The current call for educational reform is similar to one made in the 1960's,although then it was made to eradicate poverty and now it is made to keep the U.S. competitive in the world marketplace. The present report reviewed the results of previous intervention programs to determine if simply expanding on present efforts might make a significant improvement in the nation's cognitive ability.

Findings. Project Head Start was initiated as the government's major preschool program - geared to make children from a poverty background smarter and better prepared for success in schools. These programs used intelligence tests and tests of reading and mathematics achievement to test program effectiveness. A review of these programs showed that they made initial improvement in cognitive skills, but these improvements faded over time after children entered school.

The Perry Preschool Project, the one preschool program which provided sufficient follow-up data on students to determine the long-term effects of preschool,was reviewed to determine whether or not long term differences were found in cognitive skills, work and earnings between program participants and a control group. The review found that IQ and functional reading test scores were not different for these groups, and there were no differences in rate of employment or job satisfaction between those attending and those not attending preschool. **Overall, no evidence was found to suggest that any preschool or Chapter 1 compensatory education programs made long term, permanent improvements in cognitive ability.**

Youth and adult programs that were reviewed were typically not assessed in terms of intelligence scores. Analyses of the cost-benefit of the Job Corps showed that the primary factor contributing to making the Job Corps cost-benefical was the fact that Job Corps members did not commit as much crime while they were in residence at the camps as did non-Job Corps comparison groups. Those studies that did assess cognitive ability in Job Corps as well as military programs and Right-to-Read programs showed that program participation was generally brief, gains in reading tended to be inflated by statistical regression and warm-up in test-taking, and even at that the improvements typically moved 4th or 5th grade reading adults up to a 6th, 7th, or 8th grade level, leaving the majority of program participants functionally illiterate in terms of contemporary standards. One study suggested that such gains may dissipate within a few weeks after leaving the program. In general, the research base on cognitive improvement at the youth or adult level is very skimpy.

New programs are emerging that focus on the intergenerational transfer of literacy from parent, usually mother, to child. However, while some preliminary findings suggest cautious optimism regarding the potential of such programs for improving the cognitive skills of both parents and their children, there is insufficient data available to permit firm conclusions.

Contemporary Cognitive Science

Given the disappointing outcomes of the review of past and ongoing intervention programs aimed at improving the nation's cognitive ability, it was decided that perhaps the relatively new field of cognitive science might offer new perspectives that would aid in the development of new, more effective interventions. Consequently, a Conference on the Intergenerational Transfer of Cognitive Skills was convened in April of 1988 in San Diego, California to discuss a wide range of issues regarding the nature of cognition, how cognitive ability develops, and what educational implications can be derived from this scientific study of the mind.

Findings. The field of cognitive science offers new ways to think about making the nation smarter. The cognitive science approach to the understanding of cognition and its development includes several important assumptions that distinguish it from earlier approaches. First, as opposed to the notion that the development of intelligence occurs only during early childhood, development of cognitive ability is considered to operate across the lifespan. Second, cognitive scientists are interested in the internal processes of cognition (comprehending, picking-up, encoding, and utilizing information) not simply the end product or behavior. Third, knowledge and the processes used to operate on knowledge are considered to be inseparable. And finally, cognitive scientists have questioned how much generality exists in the use of cognitive abilities across tasks. More and more, cognitive processing is understood to be dependent on the nature of the task and the nature of the information used within that task. This emphasizes the need to develop ability within the context of the types of situations and tasks to which one expects knowledge to be applied.

The influence of computer scientists has lead to the concept of an "architecture" of a human cognitive system that is based on the metaphor of the mind as a computer. While this is only a tool for thinking, and not an actual theory of mind, it has incorporated many important components which have aided the understanding of human cognition and education. For example, the architecture of cognition includes long term memory, where all knowledge that has been learned is stored. The long term memory has an essentially unlimited capacity. There is also short term memory or "working" memory which has a limited capacity and which communicates between the senses and the environment and long term memory. By understanding the nature of these memory processes it has been possible to understand the learning and eventual expertise of new tasks. Research has indicated that by automatizing certain subskills, more working memory capacity is freed to use other, higher order skills. These findings have provided much information about how to structure the instruction of new information.

Another very important concept is the dual nature of cognition. This suggests that all human intellectual abilities require both processes and knowledge. This, in turn, suggests the near futility of improving cognitive ability by teaching processes in isolation, such as teaching "reading," "writing," or "critical thinking" as content free processes. The work of cognitive scientists has confirmed the importance of knowledge and context for facilitating learning and transferring this learning to other settings.

While genetics provides the anatomical structures and physiological functions that make the individual capable of cognition, research indicates that **society and culture provide the most important resources for human cognitive development**. Society and culture provide language and the conceptual knowledge that are the primary means for transmission of cognitive ability, and they also direct it's development by the value placed on learning which provides the motivation to pursue and persist in education.

The intergenerational transfer of cognitive ability comes about through many social mechanisms such as the interpretation of new experiences that parents make for children, the language that is used in the culture, the belief that one can improve one's life through education, and the value that is placed on achievement. In general, the culture and society that a person is born into provides **social capital** in the form of both socially transmitted knowledge and, most importantly, social support and motivation for participating in education.

Society and Cognition

The review of cognitive science suggests that cognitive ability is knowledge and information processing skills that are socially developed and distributed within society both in and out of school. The traditional view of cognitive abilities assumes that cognitive "potential" is an individual matter, perhaps reflecting some inherited biological limitations to intellectual achievement. This appears to be only a partially correct assumption however. At the present time there are no biological definitions of intelligence or "potential" that define directions for or set limits on cognitive development. **The individual's potential for intellectual growth and development is primarily determined by the social and cultural groups into which the person is born and raised.**

A society that wants to bring about the development of individual **human capital** must also attend to the development of **social capital**. Based on our review of past and present intervention programs, and contemporary cognitive science it is suggested that we **should be able to revise our current educational practices and almost double the improvement of cognitive ability that the present dollars accomplish.** Double duty dollars could be obtained by investments in programs that focus on **(1) the intergenerational transfer of cognitive ability** - combining parent and child education, building on bilingual and multicultural diversity, admitting lower ability but functioning individuals into the military to increase the transfer of benefits from parents to offspring; **(2) the functional contexts of education** - teaching can and should be conducted within the contexts of meaningful tasks, jobs and information; and **(3) linking problems, practice and research** over extended periods of time.

Recommendations for the Future

Recommendations are presented for future directions for **educational policy, practice and research.** These recommendations are based on three general themes: (1) the need to attend to cross generational consequences of programs, (2) the need to attend to the social nature of cognitive development, and (3) the need to attend to the contexts in which programs are implemented and evaluated.

Policy recommendations include the need for approaches to cognitive development that give more attention to the role of school and non-school social networks. In general, more attention should be payed to the role of social environments in cognitive development. Guidance can be provided to grocery stores, gas stations and the like regarding ways to make information displays that develop cognitive abilities. Additionally, approaches should be developed that build on the cognitive strengths of cultural diversity in the nation.

In practice, the focus should be on teaching within functional contexts. Reading can be taught while learning academic or vocational knowledge; mathematics can be taught while learning to handle budgets. Educational practice should capitalize on the social nature of learning through cooperative learning and cross-age tutoring. More guidance can be provided to teachers and parents on the nature of motivation and how to promote it.

Research in education should focus on the intergenerational transfer of cognitive ability. More knowledge is required in order to develop effective intervention programs. Research should be targeted for specific populations. Too much research has been inappropriately generalized across diverse ethnic and social groups. There should be action research projects funded in which researchers learn about cognition while solving important problems of cognitive development. In general, there should be improved linkages among policy, practice and research communities.

The challenge for the future is how to manage the intergenerational development of cognitive ability in such a way that we can provide the human and social capital needed for making the nation smarter.

MAKING THE NATION SMARTER:

The Intergenerational Transfer of Cognitive Ability

Chapter 1

Cognition and Educational Reform

Definition

Cognition; Cognitive (adjective): (1) The mental process or faculty by which knowledge is acquired;(2) that which comes to be known, as through perception, reasoning, or intuition; knowledge. (The American Heritage Dictionary, 1976)

New generations born into a society acquire bodies of knowledge passed on from preceding generations. They do this as a result of natural experience in the day-to-day activities of life, and as a result of participating in social activities directly aimed at transmitting knowledge.

In the United States today, a major societal tool for transmitting knowledge, the public schools, has come under heavy criticism. In the last five years, over two dozen major reports have criticized the public schools and the teachers who work in those schools.[1] Without exception, these reports note that hundreds of thousands of students dropout of school before obtaining a high school diploma, and many of these dropouts have achieved only lower levels of cognitive abilities. It has been estimated that one out of eight (13%) of those who do graduate from high school are "functionally illiterate."[2]

Cognition, Poverty, and Productivity

For those who reach adulthood having achieved only low levels of literacy and other cognitive abilities, unemployment or a lifetime of underemployment, welfare, and poverty is not unusual. Blacks and Hispanics suffer more from failure to achieve higher levels of knowledge and information processing skills, and economic problems are more frequent and more difficult to overcome in these groups.[1]

In addition to contributing to the perpetuation of poverty among various groups, it has been suggested that the consequences of low productivity in the education system is low productivity in the workplace, and this has resulted in the United States losing its competitive edge in the international marketplace.[2]

Cognition, Demographics, and Work

The nature of problems of unemployment or underemployment, and competitiveness in the international marketplace are expected to change in the future due to two major trends. One is that the population of youth is declining, except for minority groups. This

means that minorities with lower cognitive abilities will make up a greater percentage of the work force in the years ahead.[3]

The second trend is that the nature of work in America is changing. On the one hand, the largest number of jobs are in the less cognitively demanding and lower paying sectors and hence, while jobs for the less numerous youth population will be available, they will be poorer paying ones. On the other hand, studies sponsored by the U. S. Department of Labor argue that a large number of the new jobs that will be created between 1984 and the year 2000 will demand higher levels of education and higher level cognitive ability to rapidly learn new knowledge and skills as jobs change in the wake of new technological advances.[3]

The two trends taken together have lead many to suggest that in the next few years there will be fewer young adults with the cognitive ability needed to meet the demands of the better paying jobs that will make the United States competitive in the international marketplace. Therefore, it has been argued, there is a need for educational reform to improve the productivity of the schools, so they may raise the cognitive levels of students, thereby improving the productivity of the workforce of the future and enhancing the international competitiveness of the United States.[2]

Calls for Education Reform Across Generations

Contemporary calls for educational reform bear a remarkable resemblance to calls for reform a generation ago, in the 1960s. Then, however, the rallying call for reform was not the threat of the United States losing out in the international economic order, but rather the need to eradicate poverty. Beyond that, the arguments for improved cognitive competence seem quite modern:

> Incompetence and poverty are interrelated. As a characteristic of individual persons, incompetence results in poverty. And the poverty of one generation becomes, by virtue of the circumstances which hamper the development of abilities and motives, a basis for the incompetence of the next generation. As the burgeoning role of technology in our society calls for higher and higher levels of competence in larger and larger supply, those without at least fairly high levels of competence find it harder and harder to earn their way in the marketplace and to participate in the affluence deriving from our technology. [4]

A generation later a major call for educational reform again emphasized the importance of cognitive competence in the marketplace, but this time the call resulted not from concern for the poor, but from concern that "Our once unchallenged preeminence in commerce, industry, science, and technological innovation is being overtaken by

competitors throughout the world." [2] The 1983 report on **A Nation at Risk** goes on to say that:

> Knowledge, learning, information, and skilled intelligence are the new raw materials of international commerce....If only to keep and improve on the slim competitive edge we still retain in world markets, we must dedicate ourselves to the reform of our educational system for the benefit of all - old and young alike, affluent and poor,majority and minority. Learning is the indispensible investment required for success in the "information age" we are entering....The people of the United States need to know that individuals in our society who do not possess the levels of skill, literacy, and training essential to this new era will be effectively disenfranchised, not simply from the material rewards that accompany competent performance, but also from the chance to participate fully in our national life (p. 7).[2]

Making the Nation Smarter

"Even the best among us will have to become smarter."
Donald E. Petersen, Chief Executive Officer
Ford Motor Company (Education Week, Oct. 12, 1988)

Competence, knowledge, literacy, learning, information, and skilled intelligence are all words that refer to cognition, that is, knowledge and the mental processes for obtaining knowledge and applying it to the demands of life. In common words, there is today widespread concern for **making the nation smarter**.

But while the concern is widespread, there is no clear understanding of just what it is that should be improved nor how to go about improving it. In many reports, "literacy" has been singled out as in need of improvement. But "literacy" rapidly becomes an unknown concept as the results of studies come in showing great deficiencies in "scientific literacy," "geography literacy," "history literacy," "computer literacy," etc. While these studies suggest that "literacy" is content knowledge, others talk about "basic skills" of reading and writing as though these are content-free "skills."[1] Furthermore, though "reading" is sometimes talked about as a "basic" skill, easily mastered by primary grade children with a healthy dose of phonics, others note that the higher level reading tasks on the National Assessment of Educational Progress more and more resemble measures of

"verbal intelligence" that may be quite resistant to improvement with even great amounts of effort over extended periods of time.[10]

The cultural changes that are taking place in regard to cognitive development also show themselves in concerns for just when formal education should take place. Many argue today for pre-school education to prepare children for mainstream education.[20] In particular, this type of education has been advocated for poor children in recognition of the positive correlations between such socioeconomic indicators as income and parents education level and success in school. To a considerable extent, success in school is predictable before children enter school based on socioeconomic indicators and tests of cognitive ability (such as intelligence and pre-school achievement tests of reading and listening).

In addition to preschool education, many argue that people can no longer expect to "complete their education" upon graduation from high school. More and more, the workplace will demand "lifelong learning" as technology changes and demands recurrent retraining of the workforce. [33]

A Positive Outlook on Education

Criticism of the education system should not lead us to minimize the importance of formal schooling in the development of cognitive skills. Indeed, there are indications that it is precisely because we have been so successful in educating our mass population that we are experiencing many of our present difficulties. For instance, with greater numbers of persons acquiring a high school diploma, employers can demand higher credentials. This leads to the situation in which, to gain a competitive edge, more and more graduates of high schools enroll in college. This raises the general education level of the work force, which in turn causes the Department of Labor to suggest that the jobs of the future will require more education.[3] This occurs not because the vast majority of the jobs of the future have been demonstrated to actually demand the cognitive ability that generally accompanies more years of education. Rather,the projected statistics regarding how much education the future work force will *need* reflect the fact that people will actually *have* more years of education. The Department then turns these projected supply figures into demand figures in recognition of the tendency of employers to demand what is available.

Not only does the achievement of greater numbers of years of education produce a demand for more years of education to be competitive within our society, the evidence is overwhelming that, when effective, schooling is an efficient method for transmitting cultural knowledge from one generation to the next. Given the large size of its population and the diversity of its people, the United States has been quite successful in using public and private schools to make the nation smarter. The overwhelming majority (86 percent) of young adults earn a high school diploma or its equivalent by the time they are 25-29 years old.[28] Over 80 percent of young adults aged 21-25 years old perform literacy tasks better than typical eighth grade students, and sixty percent perform better than typical eleventh grade students.[29] The median score of the young male adult population of today on the Armed Services aptitude test for enlistment is slightly higher than that of the World War II male population,[30] and it has been argued that the general intelligence of our society has increased over the last century.[31]

How success limits success. It should be understood that, as more and more people are raised to higher levels of cognitive ability, further improvements will become more difficult to achieve. This is illustrated in Figure 1 using data from an important paper by John B. Carroll, one of the leading psychometricians in the world.[37]

Figure 1 shows the approximate reading grade level of skill for 17 year olds in 1971 and 1984 using data from the National Assessment of Educational Progress. Separate data are given for 17 year olds who live in Urban Advantaged and Urban Disadvantaged areas. Data are given for those who scored at the 0.5, 5.0, 25, and 50th percentiles in 1971 and 1984.

The data show that the Urban Advantaged at each percentile for their group were well ahead of the comparable Urban Disadvantaged group. Indeed, the Urban Disadvantaged at the 50th percentile had reading levels between those of the Urban Advantaged in the 5th to 25th percentiles. While the Advantaged students at the 50th percentile were reading at the 14th grade level, the Disadvantaged at the 50th percentile were reading 6 grade levels lower at the 8th grade level.

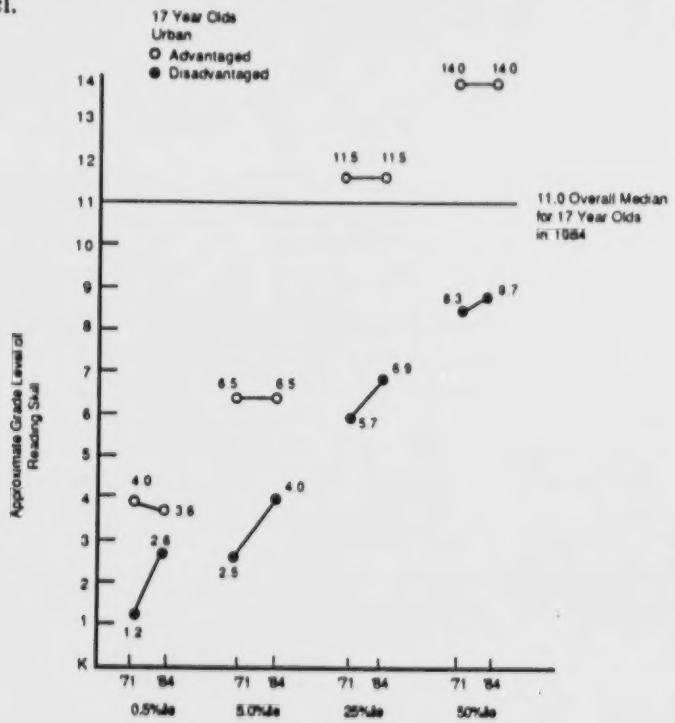

Figure 1. Changes in the reading skills of 17 year old Urban Advantaged vs. Disadvantaged groups at different percentile levels in the fourteen year period of 1971-1984.

Source: Carroll, 1987.

Between 1971 and 1984 no improvements were made in the scores of the Advantaged. For the Disadvantaged, however, improvements were made at each percentile given. Thus, in 1971, Disadvantaged at the 5th percentile were reading at a 2.5 grade level (5th month of the 2nd grade), while in 1984 the 5th percentile group of Disadvantaged had improved by 1.5 grade levels and were reading at a fourth grade level of skill.

It is important to note that the rate of improvement over the fourteen year period from 1971 through 1984 slowed down for the Disadvantaged at the 50th percentile below the rates for those at lower percentiles. This illustrates the point made earlier; as ability levels go up, it gets increasingly more difficult to raise them still higher.

The data show that in the 14 years from 1971 through 1984, the median group of Urban Disadvantaged 17 year olds improved their reading skills by about 4 months, from the third month of the eighth grade (8.3) to the seventh (8.7). From this we can determine that, with everything else held constant, if the same rate of improvement was maintained it would take some 80 years to raise the median score of the Urban Disadvantaged to the 11.0 level, which is the overall median score for the 17 year old population in 1984. To raise the Disadvantaged to the median of the Advantaged group would take about 185 years. Over this same period of time, the performance of the least able Urban Advantaged would not improve at all.

A New Look at the Development of Cognitive Abilities

In view of the numerous reports that express confused concern about the nation's cognitive abilities, the lack of faith in the present education system and its methods for developing adequate cognitive abilities in the total population, and the press for "cradle to grave" education and learning, it has seemed useful to step back and take a look at the basic issue of just what we understand about human cognition and its development, and what implications there might be of a new perspective on cognition for education policy, practice, and research.

In particular, we were concerned with what might be done to improve the cognitive abilities of the lower half of the ability range among groups suffering most economically. Recent reports have noted that investment in the development of cognitive ability in this group has been well below that of higher ability, more economically well-off groups.[28,33,71] By focusing on the lower half of the distribution of cognitive ability, our aim was to find ways to move the bottom half of the distribution upward, thereby making the nation smarter on the average. Additionally, this would contribute to the economic development of large numbers of our most needy citizens.

Approach. To gain a new perspective on cognition and its development, we conducted a review of past efforts at improving cognitive ability in the bottom half of the distribution in a variety of intervention programs, including early childhood programs such as Head Start and Chapter 1 compensatory education programs; youth programs such as the Job Corp; and youth and adult programs such as those sponsored by the Job Training Partnership Act (JTPA) and the adult education program of the U. S. and state Departments of Education.

Additionally, we conducted a review of contemporary cognitive science and educational research. Our aim here was to discover what this large body of research might have to say about how we could go about making the nation smarter.

To assist in these reviews, papers were commissioned by policymakers, practitioners, and cognitive scientists. These papers were discussed at a three day meeting

in April of 1988 in San Diego, California. A list of the conference participants is included in the appendix to this report. The papers will be available from Ablex Publishers in 1989.

Review of past intervention programs. There have been numerous reviews of early childhood education programs and youth and adult remedial education and job training programs. However, we found no reviews that examine the childhood, youth, and adult programs together with an explicit focus on the understandings of human cognitive development that appear to underly their development and operation, and which consider their outcomes with a strict focus on the extent to which they appear to have improved the cognitive abilities of the participants.

In this review, our focus was not on whether or not programs produced valuable outcomes such as reduced teenage pregnancy, less delinquency, higher rates of high school completion, increased employment, etc., in a cost-beneficial manner. Rather, our concern was on whether or not the programs made permanent, practically important improvements in people's knowledge and the mental processes used to acquire knowledge in an *intellectual* cognition sense, as indicated by improvements in intelligence test scores, or reading, writing, and arithmetic test scores, or in various assessments of knowledge in general vocabulary, science, or other special knowledge content areas.

Our focus on *intellectual* cognition as indexed by various standardized tests was prompted by the fact that it has been performance on such tests comparing the United States to other nations, or reporting significant proportions of our population as "functionally illiterate" that has been used to challenge our competitiveness on the international scene,[2] to explain why some people exist in poverty,[1,4] and to undergird the numerous calls for educational reform. It seems reasonable, therefore, that if we are going to use such instruments to identify our intellectual and educational problems, we also use them to determine whether we have solved such problems. Chapter 3 summarizes our findings on the effectiveness of past and present educational intervention programs in bringing about long term, permanent improvements in cognitive ability.

Review of cognitive science. Since the late 1950s and 1960's, a multi-disciplinary approach to the study of human cognition has emerged. Contemporary cognitive science includes the disciplines of anthropology, computer science (in particular, work on artificial intelligence), linguistics, neuroscience, philosophy, and psychology.[38] Specialists within these scientific disciplines have applied their research methodologies and theoretical concepts to understanding human cognition within a variety of cultural and social settings, and across the lifespan.[39,40,78,87,91] They have studied cognitive abilities such as "intelligence", literacy, mathematics, and critical-thinking as these are used and developed in school and non-school settings such as homes, grocery stores, clubs, and workplaces.[41,42,43,44,45,46,90] Our review of cognitive science [34] aimed to discover what this relatively new field of enquiry might have to offer for new directions in cognitive development (see Chapter 4).

A new perspective on educational reform. Our study of intervention programs and cognitive science has permitted a new perspective on educational reform. This new perspective is based on a growing recognition that human cognition and its development is primarily a *cultural and social phenomenon*. While it is understood that the person's biological make-up and physical environment are critical to cognitive development, the major source of cognitive ability is the *social* environment into which the child is born. It is the social environment that provides the basic tools of thought, including language, concepts, and the means and motivations for engaging in cognitive activities that are socially defined as "intellectual" in nature.

Chapter 2 provides a summary description of the new conceptualization of cognition advanced by contemporary cognitive science, and suggests cost-effective educational reforms that could improve the productivity of education and contribute to **making the nation smarter.**

Chapter 2

Society and Cognition

The major results of our survey of intervention programs and cognitive research are organized within a framework that reflects an understanding of cognition as knowledge and information processing abilities that are socially developed and distributed within our society both in and out of school. From this perspective, the traditional role of the schools as helping each child develop to the most of his or her "potential" requires revision.

The traditional view assumes that cognitive "potential" is a property solely of the individual child, perhaps reflecting some inherited biological limitations to intellectual achievement. However, our review reveals that, **at the present time there are no biological definitions of intelligence or "potential" that define directions for or set limits on cognitive development.** This does not mean that a person's biological make-up is unimportant in cognition and its development. Each individual must be genetically endowed with the biological structures and functions that make intellectual development possible. Further, each newly conceived individual needs to develop physically in a pre- and post-natal environment that is free from trauma and adequate in nutrients to support biological growth in a healthy manner.

But while good "nature," defined as a sound biological make-up, and good "nurture," defined as a pre- and post-natal environment that provides adequate food, air, water, shelter, etc., are necessary, they are not sufficient to ensure that good cognitive development will occur. Contemporary cognitive science now suggests that intellectual "potential" is to a large extent socially determined. That is, given normal biological make-up and an adequate physical environment, **an individual's potential for intellectual growth and development is primarily determined by the social and cultural groups into which the person is born and reared.** To illustrate this point with an obvious case, we note that an individual born and raised in an illiterate society will not develop the intellectual abilities involved in literacy.

Similarly, a person born into a literate society may not acquire the cognitive abilities needed to perform tasks involving literacy if the family and community social groups into which he or she is born do not value and use literacy in their day-to-day lives.[40]

The social nature of cognition is also evidenced by the fact that all standardized tests of intelligence that provide Intelligence Quotients (IQs), and all standardized tests of achievement in reading, mathematics, science, history, etc., such as those used in the National Assessment of Educational Progress (NAEP) are based on comparisons of individual or group scores to a distribution of scores produced by a social comparison group called the "norming" group. In short, the only way we know how smart a person is is to compare the knowledge and thinking skills of that person to the knowledge and thinking skills of others.

To a very large extent, a human society is cognition: it is a network of intelligences developing and exchanging knowledge among its members and from one generation to the next. Within this framework, an individual's intellectual "potential" is no better than the network of intelligences into which he or she can "connect." For this reason, a nation that desires to bring about the development of individual "human capital"[33] must also attend to the development of "social capital."[70]

A New Perspective on Education Reform

The social basis of cognition suggests a new perspective on education reform. Many recent reports call for *expansion* of current programs, at a cost of tens of billions of dollars.[1,28,48] However, given the current federal deficit, it seems unlikely that such large sums will be forthcoming.

While there can be no gainsaying the need to make sizeable increments in spending for education, it is also important that the dollars spent produce maximum results. Fortunately, the results from research in education and the cognitive sciences suggests ways that we can have ***"double duty dollars."*** Our review leads us to suggest that by applying what we have learned from past and present intervention programs to modify cognitive abilities, and from two decades of basic research on human cognition, **we should be able to revise our current educational practices and almost double the improvement in cognitive ability that the present dollars accomplish.**

There are at least three directions that could be taken to increase the productivity of our education dollars:

Focus on the Social and Intergenerational Transfer of Cognitive Ability.

For the most part, education programs in operation today focus on improving the cognitive abilities of one group. Head Start and Chapter 1 compensatory programs are focussed on children, the Job Corps focusses on youth, and adult basic and secondary education programs focus on adults. However, as noted,research in the cognitive sciences more and more supports the idea that the cognitive abilities of a new generation are formed in social interactions first with the preceding generations, and later with contemporaries and younger generations, as well as the preceding generations. Parents, older brothers and sisters, and others, such as doctors, nurses, aunts, uncles, neighbors, etc. interact with and teach the new born infant; children in the neighborhood and at school learn from each other and older children as well as from teachers; and youth and adults learn much of their "practical" knowledge, such as keeping up the house, caring for one's possessions, and learning work skills through informal "cognitive apprenticeships" with parents, friends, and other associates.[45]

The social-intergenerational perspective on cognitive development suggests approaches that might be taken to increase the numbers of people served by intervention programs and the amount of cognitive growth accomplished within present or only slightly expanded funding levels.

Combined parent and child education. Research shows that,in general, parents with higher education have children who persist in school longer and achieve better than children whose parents, and especially the mother, have low levels of education.[8,29] Furthermore, parental involvement is a key factor in pre-school experimental programs, Head Start, and compensatory schooling, and much of the success of these programs has been attributed to this involvement.[16,18,48,87,88]

However, while parent involvement is a key feature of most early intervention programs, the programs do not focus on improving the parent's education level or intellectual cognitive abilities. While parents may be taught certain "parenting" knowledge, such as health care, how to stimulate the cognitive abilities of their children, and so forth, the programs do not,for the most part, aim at improving parent's literacy, mathematics, and other intellectual abilities. We found no early childhood programs that assessed the growth of parent cognitive abilities in reading, mathematics, or intelligence as a consequence of participating in the program.

Some less well educated parents attend adult basic education classes funded by federal and state governments. But the combined federal and state budget for adult education is less than five percent of the budget for childhood programs,[36] and the program reaches less than ten percent of the eligible population.

There is evidence to suggest that if significant amounts of the monies currently spent on early childhood and compensatory programs for children were used to develop programs to improve the intellectual cognitive abilities of youth and adults, especially those that are or will soon become parents, the number of youth and adults served could be greatly expanded **and the education of the parents could transfer to their children in the form of improved cognitive ability and improved motivation for attending school.**[8,51,52,53]

Currently, over $5 billion in federal funds are spent to provide preschool education (Head Start) and compensatory education in the primary grades (Chapter 1) for children.[28] According to the Congressional Budget Office,[49] evaluations of these programs show that, whatever else they may accomplish, they do not make long term, permanent improvements in children's cognitive abilities as measured by intelligence and achievement (reading; mathematics) tests. Gains that are made early on, dissipate after the third or fourth grades. For this reason, there have been calls for follow-on programs.[19,50]

By addressing significant amounts of the Head Start and Chapter 1 efforts to the education of youth and adult parents or parents-to-be, as is currently being done in a limited manner in the new Even Start legislation,[58] a multiplier effect could be achieved. Not only would the number of youth and adults being served increase, but each participant who is or is about to become the parent of one or more children might pass on their educational benefits to one or more of their children. Further, improved parent education might serve as a sort of "follow-on" program for the rest of their children's years in school.

Building on bilingual and multicultural diversity. If greater international competitiveness and cooperation will be called for in the future, as many education reformers have suggested,[2] then it would seem prudent to more productively utilize the human capital that the United States possesses in the diversity of language and cultural backgrounds in the growing percentage of the population that comes from a variety of

minority groups. Bilingual skills and knowledge of two or more cultures are valuable cognitive resources for our nation. Such resources should be appreciated for the human and social capital[70] they provide, and ways should be sought to promote the bilingual and bicultural development of those who begin their lives in social groups that foster these valuable abilities and knowledge.

It is more cost-effective to build on existing language and cultural knowledge to produce international bankers, business associates, journalists, government specialists, and so forth, than to permit such natural resources to atrophy while attempting to develop new resources from scratch at an advanced educational level in monolingual, monocultural "majorities." A greater use of bilingual, bicultural teachers in the schools, a greater emphasis on learning in a bilingual manner, and **a greater emphasis in the values, thought, and history of diverse cultures could produce significant new amounts of human and social capital for the United States to engage in international commerce and political activity.**

Cross-age and peer tutoring. The social basis for cognitive development is supported by research within schools showing that greater use of older students to tutor younger students can have multiplier effects: both the tutor and the tutee learn more, and their dropout rates may decline.[54] Additionally, a growing body of research suggests that students benefit from peer-tutoring and from *cooperative learning* in social teams of two or more.[60,80] **Because students form the largest body of human resources in the schools, they could be better organized and utilized to develop cognitive skills both within and across age groups.**

More "bang for the buck." A recent review of the military's use of lower educated, less literate personnel in World War II, Vietnam, and the All Volunteer Force indicates that, while such personnel do not perform quite as well as those at the higher levels of education and cognitive ability, they perform about as well as average personnel.[55] Further, many thousands of less educated personnel take advantage of the military's educational benefits, including both the benefits available during their service time, and the post-service benefits, such as the various versions of the "G I Bill." It has been noted that the children of those who used the G I Bill after World War II went further in school than those who did not use that benefit.[56] This suggests that the present use of less educated personnel by the military might be expanded. This way, security needs of the nation could be met, while meeting the education and training needs of many less educated, lower ability young adults. Then, for those who become parents, **the possiblity exists for an intergenerational transfer of military benefits to improve the educational attainment of the next generation.**[57]

Focus on "Functional Context" Education.

Anthropological, sociological, and psychological research in cognitive development has revealed that much of the difficulty children and adults have in learning and applying new knowledge and information processing skills results from the fact that much education and training is given out of context.[22,45,59,60] Reading is generally taught as a process, in which the content being read plays no role; mathematics is usually taught as an abstract subject matter rather than practical knowledge; history is presented as a topic, not as a means to solving social and political problems, and so forth.

The decontextualiztion of subject matter from functional contexts results in such beliefs that "first you learn to read, and then you read to learn." This is the widespread belief that causes schools to teach reading in the primary grades as content-free processes, with the idea that once this "basic skill" is learned, it can then be applied to learn the "real stuff," that is, the content knowledge areas of the curiculum at the higher grades.

In programs for youth and adults, the decontextualization of education leads to the belief that literacy "levels" must first reach a certain "height" before one can learn vocational or other technical knowledge. The "basic skills" are thought of as something that one must first get and then apply.But the foregoing misses the point that **literacy and mathematics and critical thinking can all be acquired while they are being applied to learn valuable knowledge and problem solving skills.**

The fact that information processing skills such as reading and writing can be acquired while learning valuable content and problem solving abilities suggests that considerable cost-savings might result from greater integration of basic skills, content, and applications learning. Three examples illustrate how this integration might be achieved.

Children's Learning in School. Contemporary cognitive science reveals that comprehension, whether by listening or reading is not possible without a considerable body of knowledge about what is being listened to or read about.[41,43] For this reason, it is possible to improve reading ability, for instance, by improving one's knowledge in the domain to be read about. This means that many non-reading learning experiences, such as field trips, television viewing, and so forth accomplished prior to reading can contribute to improved reading comprehension. But it is important that such activities be discussed in social interactions by each child so that the experiential knowledge can be recoded in language because, to a very large extent, language mediates comprehension, thought, and further knowledge acquisition.[39]

By engaging in socially organized, task-oriented activities, such as team cooking a meal, children can learn the functional significance of reading by reference to such tools as lists of groceries, cook books, and recipes.[60] Writing may be improved while teaching its functional applications.[61] Mathematics can be learned within the contexts of tasks such as designing a house, measuring a dress pattern, shopping at the store, and so forth.[42,45] By teaching the "basic skills" within functional contexts, not only are the skills learned, but also their applications to problem solving and task performance. Thus, **education dollars can be more productive in promoting learning in the schools and in transfering knowledge and skill more effectively to activities outside the school.**

Integrating Vocational and Basic Skills Training for Youth and Adults. Many job training programs and vocational programs for youth and adults, such as those sponsored by the Job Training Partnership Act or the Job Corps, require that participants first go to decontextualized basic skills programs if their basic skills are lower than thought required for a particular job training program. This adds time to the program, and may lead some participants to drop out because the basic skills program is not what they came for.[22]

However, by recognizing that basic skills can be developed while learning job skills, cognitive scientists have demonstrated that job training programs can be developed that integrate the teaching and learning of literacy, mathematics, and problem solving skills into

the functional context of technical training.[22,62] This provides ***double duty dollars*** for vocational training by permitting the simultaneous acquisition of technical knowledge and mathematics, and the information processing skills needed to read, write, and critically think about the field. Further, research suggests that such content-oriented basic skills programs generally produce as much or more improvement in "general literacy" as do the decontextualized, academically-oriented, "general literacy" programs currently in use.[22,62]

Combining Knowledge and Information Processing Skills Assessment. The belief that reading, writing, mathematics, science, history, geography, vocational training, and other bodies of knowledge are separate has lead to expensive national assessments in which one battery of tests assesses, say, reading, and another battery assesses science, mathematics, history, etc. knowledge. However, all of the latter knowledge tests are generally presented in the written language and require reading. But they are not considered as reading tests.

Because all reading comprehension assessment must use some knowledge domain to be comprehended, it is possible to assess both reading and knowledge in an area in the same battery. By properly designing the tests, one can find out if a person possesses knowledge in a domain, and, if not, whether the person can acquire that knowledge using reading skills applied to a text that presents the relevant information. In this approach, both content and skills tests can be integrated to acquire assessment information in a more cost-effective manner.[63] With something as costly as the National Assessment of Educational Progress, the savings could be substantial.

Focus on Linking Problems, Practice, and Research over Extended Periods of Time.

Policymakers, practitioners, and researchers at the conference on the intergenerational transfer of cognitive abilities were all in agreement in recognizing the need to more closely link the educational problem groups, such as the urban disadvantaged or rural Native American disadvantaged, with capable practitioners and cognitive scientists. Too often, researchers are based at universities or other "think tanks" where they conduct research that is too brief and limited in the samples and cultural contexts involved to permit valid generalizations to new problem contexts and populations.[64,65,66] Hence, long term problems persist, as in the improvement of reading skills in the urban advantaged as indicated in Figure 1.

Even if generalizable, research is too often simply published in an academic journal where it awaits discovery some years later by someone seeking to solve an important education problem. What is likely to be found, however, is that a given body of research is not directly applicable to the problem at hand, and so new research must be done to adapt earlier approaches to the new context.This weak link between research and its application is costly both in money and in the persistence of human suffering.

A further problem that reduces the cost-benefits of both research and education is that, unlike medical schools, which require that its practitioners be prepared with a solid foundation in the medical sciences, schools of education do not prepare teachers and administrators with a sound foundation in the cognitive sciences that underpin education.

These two issues, weak links among educational problems, practitioners, and researchers, and poor preparation of educators in the cognitive science foundations of education suggest two major activities that could bring greater returns on our investments in educational and cognitive science research.

Cognitive Action Research. There is a growing movement to study cognitive development outside the school in "real world" social settings such as community locations (business sites; grocery stores; etc.)[22,45,46] This type of work could be built on to include not only researchers doing research, but also researchers doing practice.

Through cognitive action research, scarce research funds could do double duty. **Basic knowledge about cognition could be developed while simultaneously solving important educational problems by having cognitive scientists based in community settings serving as both scientists and practitioners.**

The latter role could include activities such as providing technical advisory services to schools, families, businesses, and other community organizations as well as individuals.

In addition to advisory services, education programs aimed at the intergenerational transfer of cognitive abilities from parents to children, or from older children to younger children might be provided. Such programs could include practitioners trained to be not only skilled in serving and teaching, but also as enquirers who contribute to the knowledge generating activities of the cognitive research.

With multidisciplinary scientists and practitioners working on significant educational problems, located in geographical areas where the problems exist, and over long periods of time, scientifically valid knowledge could be developed about the linguistically and culturally diversified populations that make up the U. S. citizenry. Research findings would not lie dormant on library bookshelves before being applied. Rather, research findings would be generated while cognitive research and educational practice methods were being applied to solve important problems of both cognitive science and cognitive development.

Cognitive Science Synthesis and Dissemination. There is an abundance of useful knowledge in the cognitive sciences, but it has not been synthesized and disseminated to practitioners, other researchers, or the interested general public in a learnable manner. Because of the multidisciplinary nature of cognitive science, and the intensive, focussed nature of research, it is difficult for cognitive scientists and educational researchers to have more than limited understandings of the full spectrum of knowledge being generated.

Many cognitive scientists have not given a great deal of thought to how their knowledge could be used to improve human cognitive development in and out of schools. It is left to others to provide a translation of the scientists findings into educational applications.

The translation problem is even more serious when schools of education are concerned. Professors have difficulty grasping the full range of anthropological, computer science, linguistic, psychological, and sociological knowledge about cognitive

development. It is not surprising, therefore, that teachers in schools of education receive next to no education and training in the cognitive science foundations of education. This results in part from the fact that there has been no synthesis of this large body of knowledge into a coherent curriculum. Current efforts at synthesis and dissemination focus on having different people write papers for books or monographs. These papers are then stored in the various Educational Research and Information Centers to be consulted by students working on master's or doctoral theses. Given the tens of thousands of papers produced each year, and the circumscribed time and interests of professors of education and their students, it is not possible for large bodies of knowledge across multiple disciplines to be mastered.

A major project to produce a multi-media curriculum in **The Cognitive Science Foundations of Education** could provide a transportable vehicle for use among researchers, schools of education, and other groups, such as community-based education and training organizations, businesses, industries, and government organizations. By using videos, computers, and well designed textbooks, along with both laboratory and field experiences, such a curriculum could present a coherent understanding of human cognition and its development, and practice in applying such knowledge to educational needs. This should produce returns to our investment in educational research synthesis and dissemination well beyond the current publications-based efforts of educational resource centers. This would no doubt make future investments in educational and cognitive science research more palatable to congressional policymakers.[58]

A Challenge

The present chapter has offered a new perspective for educational reform, and it has illustrated with a few examples how this new perspective might lead to **"double duty dollars"** that can produce more cognitive development for the money presently being spent on education. It is hoped that readers of this report will be stimulated to consider the social, intergenerational nature of cognition and its development, and invent additional ways to make education a more cost-effective activity both in and out of school.

The changing world scene, changing demographics, and the changing understanding of human cognition offer a challenge: **how to manage the intergenerational development of cognitive ability in such a way that we can meet the needs for human and social capital of the foreseeable future.** Chapter 3 reviews past and present educational intervention programs and suggests that simply expanding and enlarging upon what has been done in the past is not adequate. New approaches are needed for **making the nation smarter.**

Chapter 3

Intervention Programs

In the later decades of the nineteenth century attention was focussed on the fact that more literate, better educated, and more highly intelligent parents somehow transfer cognitive abilities to their children.[10] It was noted that more intelligent parents, as measured by the new "intelligence tests," produced more intelligent children who achieved better in school and went on to become the better educated and achieving adults. It was thought that intelligence, defined in operation as the Intelligence Quotient (IQ), was largely an inherited and unchangeable trait that parents transmitted genetically to their children.

In the late 1950s, however, evidence was amassed to suggest that most of an adult's intelligence, as indicated by IQ tests, was developed by the time he or she was only 5 or 6 years old [11] and that experience during this early period of childhood could be expected to change the child's IQ.[12] These ideas lead to the War on Poverty's early childhood interventions to break the cycles of low intelligence that lead to low school achievement which, in turn, was thought to lead to low employability and poverty.

In the 1960s, the **intergenerational transfer of cognitive ability** was emphasized in the analyses of the causes of poverty, and suggested why it was necessary to try to make the poor smarter. For decades it had been observed that many children from poverty backgrounds arrived at kindergarten or first grade with knowledge and language backgrounds that ill-suited them to benefit from mainstream public education. These children frequently fell behind in school, and many dropped out before completing high school. They became the marginally literate and marginally employable youth and adults with cognitive abilities that comprised the lower one-fifth to one-third of the adult population of the time. Large percentages of black and Hispanic adults fell into these categories.[5]

Many of these poor and poorly educated young adults became parents of children and were unable to provide the preschool oral and written language experiences and the "school-like" ways of thinking that are the foundations for learning to read and write at school.[6,7] Without these preschool basics in language,literacy, and critical thinking, the children from homes where the parents were poor and poorly educated frequently showed up for school prepared to recapitulate the failure of their parents, and the cycle repeated itself.[8,9]

Intervention Programs

The 1960s witnessed the proliferation of numerous education and training programs aimed at improving the cognitive skills of children, youth, and adults from poverty backgrounds.

Children's Programs

In addition to a variety of experimental preschool programs[13], Project Head Start was initiated as the government's major preschool program to make children smarter and better

prepare them for success in the schools.[14] Efforts to help children from poverty backgrounds develop their cognitive abilities after they entered school were implemented in Follow Through and Title I of the Elementary and Secondary Education Act of 1965. Through "compensatory education," it was hoped that the schools could compensate for the inadequate preschool preparation and home environment that was thought characteristic of poor children and help them attain higher levels of achievement in school.[15]

Using intelligence tests and tests of achievement in reading and mathematics, the experimental preschool programs and Head Start programs made initial improvements in cognitive skills, and then these improvements faded over time after the child entered school.[16,17,18] Similarly, the Compensatory Education programs made improvements in reading and mathematics achievement test scores, but these improvements faded after about the fourth grade of school.[19]

While the intelligence and achievement test scores of the preschool and compensatory education students do not seem to have been permanently affected by these interventions, other important social outcomes have been reported.[16,18] Experimental preschool programs have reportedly reduced dropout rates, reduced teen pregnancy, reduced rates of unemployment, and reduced rates of delinquency below those of control groups.[20] Head Start programs, too, have produced beneficial outcomes, such as better health delivery and parent participation in the education of children, even though cognitive abilities as measured by intelligence or achievement tests of reading and mathematics have not been permanently improved.

With regard to preschool and elementary school intervention programs, the question is not whether these are programs that produce social benefits, clearly they do. The question is whether they improve cognitive abilities to any practically significant degree, and if so, whether those improvements are sustained into adulthood and applied to work so that poverty is reduced and productivity is improved.

The Perry Preschool Project. Only one study has been found that followed preschool program participants and control groups long enough to determine whether long term differences were made in cognitive skills, work, and earnings.[72] In this study, children who were given or not given (control group) preschool education were followed until they were 19 year old young adults.

Unfortunately, the two groups differed in one very important aspect: 9 percent of the preschool group mothers were employed outside the home, while almost one third (31%) of the control group mothers were employed outside the home. This means that control group children could not benefit from interactions with their mothers during the day to the same extent that the preschool children could. Since mother and child interactions have been shown to be very important for cognitive development,[41] this difference may have influenced the outcomes of the project. For this reason, findings below have been based on analyses for which this and other variables at the start of the project have been statistically controlled.

Regarding cognitive abilities, it was found that IQ test scores were not statistically reliably different at age 17 (both mean IQs being in the low 80's, well below average).[73] No reliable differences were found in high school grade point averages when differences between the two groups at entry to the program were controlled. Both groups had averages right around a grade of "C". After adjusting for differences between the groups at entry to the project, no reliable differences were found between the two groups at age 19 when they

were tested using the Adult Performance Level test of "real life" functional skills, such as reading consumer information. In this case, both the preschool and comparison groups scored well below the average of the norming group, which, itself, was well below average with over 75 percent having less than a high school education.[74] Further, in the Perry Preschool Study, the test items were read to the preschool and comparison groups, even though standard procedures called for the examinees to read the test. Under these circumstances, the performance of both the preschool and control groups would cast them as "functionally illiterate" in terms of adult literacy assessments such as the National Assessment of Educational Progress or the Armed Forces Qualification Test.[22]

Regarding work, after controlling for differences at entry to the study, there were no reliable differences in the numbers of those who were working at the time of the interview for the study, and there were no differences in their levels of satisfaction with their work.[72] According to some analysts, the Perry Preschool program did not result in income that raised the average participant above the poverty level, even though they earned more than control group members.[21]

To summarize, neither the Perry Preschool Study nor any other preschool or compensatory elementary school studies have produced data showing that changes in cognitive ability persisted into adulthood, and that, as adults, program graduates have escaped poverty and "work smarter" and more productively than non-program workers.

Youth and Adult Interventions

The War on Poverty produced many intervention programs for youth and adults.[15,23] Unlike the preschool and compensatory education programs, the youth and adult programs were not assessed in terms of whether or not they changed participants intelligence scores, suggesting that beliefs about the modifiability of intelligence supported the notion that intelligence was formed early.

Vocational training was the major focus of many youth programs, with some attention to remedial academic education, and perhaps attainment of a high school equivalency degree. The most prominent and enduring of these programs was the Job Corps, which is still in operation. Evaluations of the Job Corps have been undertaken to determine if it has fulfilled its goal of rendering participants employable and self-supporting.While these evaluations have suggested that the Job Corps has been cost-beneficial, the benefits accrue mainly from the fact that the Job Corps members do not commit as much crime while they are in residence at the Job Corps centers as do comparison groups.[15,19]

Studies of the improvement of cognitive abilities of Job Corps members are limited. Some reports have indicated that Job Corps members enrolled in remedial reading and mathematics may make one or two "years" of improvement, from around a sixth to a seventh or eighth grade level.[24,27] By contemporary standards this would leave the majority of Job Corps "graduates" functionally illiterate.

But the Job Corps experience is not unique. A review[25] of 32 different studies of adult literacy programs, including U.S. Army, Navy, and Air Force programs, national Right-to-Read reading academies serving over 20,000 students, several computer-assisted

or computer-managed literacy programs, as well as the Job Corpsprograms reported grade level gains of from 6 months to 3 years, with hours of instruction ranging from 2 to 141. The average gain was 1.5 years, with pre-program scores in the 4th to 7th grade level range using a variety of standardized achievement tests.

Loss of Gains Made. The finding that, for the most part, the pre- to post-program gains in youth and adult literacy programs leave participants functionally illiterate, reveals only one problem in evaluating the effects of such programs on cognitive abilities. Another problem concerns the retention of those gains after participants leave the programs. Data on the retention of gains are very limited. In the only study found that carefully assessed pre- and post-program general reading skills, and then retested program completers 8 weeks later, it was found that the 1.0 (one year) grade level gain at the end of the program dropped by sixty percent to a gain of 0.4 (four months).[26]

Intergenerational Literacy Programs: A Trend of the 1980's

In a 1975 review of adult literacy issues related to career development, it was observed that a strong relationship existed among the reading scores of adults on the National Assessment of Educational Progress of 1971 and the education level of the adult's parents.[75] Subsequent analyses led to the suggestion that by increasing our investments in the education of adults, we might improve the educability of their children through an "intergenerational transfer" of the parent's cognitive ability.[8]

Though studies of education in Third World countries have suggested that the education of parents, and especially mothers can have a positive effect on the educational achievement of their children, it is only in the last few years that "family literacy" programs of adult education aimed at improving both parent's and their children's educational achievement have appeared. Three of these programs were described at the conference on the intergenerational transfer of cognitive abilities.[51,52,53]

At the present time, it is too early to fully evaluate the work on parent and child education. What can be said, however, is that the three different arrangements discussed at the conference have demonstrated that it is possible to engage undereducated adults, generally mothers, in an education program in which measurable growth in the adult's literacy skills or completion of the high school equivalency diploma is achieved, while certain indicators of improvements in school-related behaviors (e.g., attendance) are obtained for the adult's children.

To date, evidence available is too limited to permit firm conclusions. Nonetheless, the evidence that is available suggests that the focus on both parents and children may bring about greater persistence in the program by adults, though their levels of achievement are no better than those in the adult basic education programs reviewed above. Cursory evidence suggests that these parent and child education programs may instill positive attitudes toward and improved attendance at school by the adult's children. However, it must be restated that such conclusions are very tentative; numbers of participants are small, controls for bias in self reports and teachers reports are not evident, and there are no studies of a longitudinal nature to verify the long term success of such programs.

While the full success of family literacy or parent and child education programs has yet to be determined, the commitment to the idea of designed programs to promote the cross generational development of cognitive abilities is growing. Recent legislation, called Even Start, has set aside some $15 million of Chapter 1 funds for compensatory education to be used for intergenerational programs.[58] As mentioned in Chapter 2, such programs may make it possible to get much more cognitive growth in the population for the same or nearly the same dollars.

Assessment Issues in Program Evaluation

It is possible to come away from an analysis of the effects of these various intervention programs on cognitive development feeling that they have not been very successful in developing cognitive ability. However, it should be noted that it is quite possible, indeed, even certain, that participants in these programs and thousands of other education programs conducted in and out of formal school settings learn many things that are not assessed by intelligence or standardized, normed achievement tests. For instance, none of the assessments of reading improvement in the Job Corps includes growth in vocational knowledge and the ability to read, reason with and apply that knowledge to important tasks within a given career field. Yet, there is evidence showing that people who engage in job training can read job-related materials better than can non-job trained people having the same "general" reading scores.[75]

As noted earlier, we have focussed on cognitive development measured by standardized, normed tests because scores on such tests have been and continue to be used as the primary tools for indicating that our nation is "at risk" because of educational problems. It seems logical, then, that if such tests are used to define a problem into being, they should be used to determine that the problem has been solved. In fact, this appears to be the logic behind the intervention evaluations that use change in pre-program and post-program intelligence or achievement test scores as the indicators of cognitive growth.

A major problem with the use of such tests to evaluate brief, limited intervention programs is that the scores do not reflect only what is learned in school or in any other well defined setting. Rather, they reflect learning by the child, youth, or adult both in and out of school. And the out of school learning is not insignificant. In a typical year, children are in school six hours a day for 180 days. Therefore, the child spends 1080 hours in school and 8,760 hours out of school. Of course, much of the year is spent sleeping (about 2,920 hours at eight hours a night). But still, over 55 percent of the year is spent awake and out of school.

Children at play, youth in various activities, and adults at work in the home, community, or job develop much language, knowledge, and information processing ability which, if included on a standardized achievement test may not have been learned in school, and so it is unlikely that it will be taught in a brief program. Alternatively, something commonly learned out of school may not be assessed on the test because it is not a "good" item, that is, it does not discriminate among people well enough to make it useful for that purpose. Thus, even if such knowledge were acquired in a brief program, it would not show up as improved cognitive ability in the pre- and post-test assessment because it is not assessed by the tests.

To overcome some of the above problems it has been suggested that assessment of intervention programs should be based on curriculum-specific tests to find out if students are learning what is being taught.[77] This "testing to the teaching" is different from "teaching to the test." In the latter, the test is constructed first and then a curriculum is developed to correspond to the test items. In "testing to the teaching," the curriculum is developed first and then sampled to develop test items.

While the curriculum-specific test tells how well the student learns the content of a particular program, it does not tell how much improvement in "general" the person has made, that is, how much improvement has been made in "general intelligence," "general literacy," "general mathematics," and so forth. In particular, it does not tell how well a particular program group has improved relative to a larger social group, such as a national norming group. And it is the latter that are increasingly used to evaluate the nation's educational progress.

In general, what appears to be needed is an assessment system that a program can use to both assess curriculum-specific learning for determining how well students learn what is being taught, with a separate component of the system that permits comparisons to be made with national standards of cognitive growth.

Intergenerational Transfer Issues

As "family literacy" or "intergenerational transfer" programs proliferate, spurred by the new Even Start legislation, special attention should be given to the definitions of cognitive abilities to be developed, and the need to assess the actual transfer of cognitive ability from parents to children. The latter is especially important to document the mechanisms by means of which **"double duty dollars"** can be obtained by having the parent's new cognitive ability transfer to more than one child.

It would also be useful to compare programs in which only adults are educated, to those in which adult and children are educated in parallel but separate programs, and those in which parents and children are educated together. In such programs, an effort should be made to distinguish the role of "parent involvement" in the education of their children, such as intensified interactions among parents and schools,[68] and the role of new cognitive ability of the parents such as ability to read, write, compute, reason critically in some specified domain, and so forth. Studies that involve parent's solely in motivational activities for their children's education versus studies that teach new domains of knowledge, such as vocational knowledge, could help in understanding parental influences on children's schooling and learning.

There are examples that one can point to in which practically illiterate, non-educated parents have children who excel in school. This is especially true of certain Asian immigrant groups.[42] There are other examples of parents who have educated their children at home to the point that the children qualify for admission to prestigious universities. It would be useful to know more about how these different types of parents interact with their children and how they convey attitudes and cognitive ability to their children.[76]

A number of conceptual, methodological, and delivery system issues involved in the design, implementation, and evaluation of intervention programs were identified in papers presented at the conference on the intergenerational transfer of cognitive skills.[59,65,66,81,82] Because those papers will be available from Ablex Publishers in 1989, the many points made by the authors will not be repeated here. However, it should be noted that, in general, there has not been much attention given to the intergenerational transfer of cognitive ability. Most programs are evaluated only with regard to their effects on the participants, not the progeny of the participants. More attention to the intergenerational transfer of cognitive ability might make it possible to enhance such transfer, thereby providing a more cost-beneficial method for **making the nation smarter.**

Chapter 4

Contemporary Cognitive Science

Our review of education intervention programs for early childhood, youth, and adults lead us to the disturbing conclusion that the programs have not been as effective in making long term improvements in cognitive ability as has generally been thought. For this reason, and because new intervention programs of an intergenerational nature are rapidly being implemented, it seemed appropriate to take a new look at the nature of cognition and its development, to contrast contemporary understandings with those in effect at the time earlier (and still ongoing) programs were implemented, and to determine if there is new information and understandings that might offer new directions for future interventions.

Contemporary Cognitive Science

The last quarter century has seen a new interest in human cognition and its development across a variety of scientific disciplines. In "the mind's new science," [34] anthropologists study the cultural basis of cognition, sociologists study the social distribution of cognitive skills in various groups and institutional settings, psychologists aim to better understand individual cognitive ability, computer scientists work to create "artifical intelligence," and others, such as behavioral geneticists,neuroscientists, linguists, and philosophers have formed subspecialties that study various aspects of human cognition. Taken together, this multidisciplinary enquiry into the nature, workings, and development of the mind is referred to as **contemporary cognitive science**.

Given the vast number of publications across all these fields of study, it is not possible for us to present a comprehensive survey of cognitive science. Instead, we will present a summary of major trends as we discern them, aided primarily by the papers presented at the conference on the intergenerational transfer of cognitive ability, reinforced with a review of additional materials. The footnotes to this report offer inroads to the literature on cognitive science that the interested reader can pursue for a deeper understanding of this fascinating and socially important field of study.

The Nature of Cognition

At the beginning of Chapter 1 of this report the word "cognition" and its adjectival form "cognitive" is defined as found in a modern dictionary of standard English usage. The definition makes the point that cognition has at least two main aspects. On the one hand, cognition refers to the mental processes that people use to acquire knowledge, and on the other hand, cognition refers to the knowledge that has been acquired using these mental processes.

Knowledge and cognition. One of the hallmark achievements of cognitive science is the confirmation of **the dual nature of cognition**: all human intellectual activities, such as thinking, communicating, problem solving, and learning require both processes and knowledge. This is important because it points out the near futility of attempting to improve cognitive ability simply by improving processes such as "reading," "writing," "critical thinking," and so forth without recognizing that high levels of ability in performing these processes requires high levels of knowledge on which the processes can operate.[84] It is precisely because content knowledge plays such a large role in cognition that all major tests of "intelligence" assess vocabulary knowledge (frequently in what is called the "verbal" component of intelligence[10]).

Because of the importance of knowledge to cognition and its development, cognitive scientists have made the study of knowledge a central part of their work. The focus of their study generally reflects the focus of their scientific discipline. For instance, cognitive anthropologists have studied how housewives use their knowledge of mathematics in grocery shopping; how literate and illiterate children in Brazil develop knowledge of mathematics involved in selling gum on the streets; and how dairymen invent mental labor saving knowledge for performing mathematics involved in filling milk orders .[45,46,85] these and other studies suggest that the contexts in which people work affect the type of knowledge they develop about mathematics and how well they are able to perform tasks that involve the use of mathematics. They also show that there may be less transfer of mathematical skill from academic settings to applied settings (and vice versa) than one might have thought.

Cognitive psychologists have studied information processing in reading and have found that what a person knows about what they are reading greatly influences their ability to comprehend and learn from texts. In one study, young adults in a remedial reading program required 11th grade "general reading" ability to comprehend with 70 percent accuracy if they lacked much knowledge relevant to what they were reading. On the other hand, those with high amounts of knowledge about what they were reading were able to comprehend with 70 percent accuracy with only 6th grade "general reading" ability.[63]

The "architecture" of human cognition. The influence of computer scientists who strive to develop "artificial intelligence" has focussed more attention on the role of knowledge in human cognition. It has also lead to the concept of an "architecture" of a human cognitive system that is based on the metaphor of the mind as a computer.[43,44] In this approach, the mind is considered to have a long term memory that stores knowledge. This long term memory is essentially infinite in capacity.

Additionally, there is a "working" or "short term" memory that contains our thoughts of the moment. The working memory calls on, or "addresses" knowledge in our long term memory, or what is sometimes called our "knowledge" or "data" base, and uses that information in the comprehending, learning, communicating, reasoning and so forth that it is involved in at the moment. But, unlike the long term memory, the capacity of the working memory is severely limited. We cannot keep too many things in mind at one time because of the limited capacity of our working memories. For instance, if we want to dial a telephone number, we may repeat the number over and over again to keep it in working memory long enough to dial it, then we can "dump" it and forget it.

Among the very important findings from studies of the limited capacity of working memory is that the capacity can be expanded if some of the mental processes involved are automated. For instance, in reading, it has been found that students who must occupy their limited working memory in decoding print to speech, as in phonics, cannot comprehend well what they are reading. Comprehension requires additional processing "space". in working memory, particularly in regard to addressing knowledge in long term memory and merging it with the new information picked-up from the book. In order to efficiently read and comprehend, it is necessary that the decoding aspect of reading become automatic, that is, performed without conscious attention. This can only be accomplished by hours and hours of practice in reading. This is one of the reasons why "quick-fix" reading programs cannot make much of an improvement in reading comprehension of those low in decoding skill. A second reason, of course, is that to improve reading comprehension much, one must develop a large body of knowledge in long term memory relevant to what is being read. Like skill, the development of large bodies of knowledge takes a long time.

The limitations of working memory are also a major factor in learning and applying mathematics.[29] For instance, in trying to calculate the cost of a meal in a restaurant, the working memory must deal with the locating of information and comprehending the written description of what each item was and what it cost. If working memory space must also be given to recalling how to add, subtract, multiply and divide simple two or three digit numbers, while searching the check, there is much opportunity for mistakes. However, if one has automatized a large number of calculations, such as in learning the multiplication tables up to 12 or so, then calculations can be made while working memory space is left for searching and comprehending the check.

This concept of a human cognitive system with a knowledge base in long term memory and information processing in a limited capacity working memory is one that has emerged over the last quarter century and was not understood in this sense when most of the intervention programs of the War on Poverty were designed and implemented. For this reason the important implications of studies of these system components,their contents, and how they interact with one another and with the information in the external world "outside the head" was not incorporated into the design of these programs. And, for the most part, the knowledge that cognitive scientists have developed about this system has still not influenced education programs (mainstream or intervention) to the degree that it should.

Among the problems encountered are failures to adequately develop new knowledge on the basis of old knowledge, failure to develop knowledge in a systematic, progressive manner, failure to take time to review, consolidate and reorganize old knowledge in the face of new learning, and failure to detect and "repair" faulty prior knowledge that can interfere with new learning (this is an especially important problem in science, where "common sense" understandings are often simply wrong and interfere with the learning of concepts that are not "intuitively" understood).

Lack of understanding of the concept of the working memory and its limited capacity contributes to poor practices in the teaching of subjects such as reading and mathematics. For instance, decoding while reading and calculating in mathematics tasks are both lower order skills. By automatizing such skills through extensive practice, working memory is available for performing higher order processes, such as planning, comprehending, and monitoring ones understanding.[43,86] Frequently, insufficient time is given to practice in reading or to drill in basic arithmetic operations to automate the lower order skill components of reading or mathematics tasks.

Too often, attempts made to teach "higher order, critical thinking skills" or "learning to learn skills" may be ineffective because of insufficient attention to the requirements for content knowledge relevant to what one is supposed to "think critically" about, and to the need to overcome the limitations of working memory by automating component skills of tasks or by other techniques (such as taking notes).[86] The concept of a human cognitive system with its knowledge base and working memory can serve as a useful heuristic for designing better educational programs.

Development of Cognitive Ability

A contemporary understanding of the development of cognitive ability entails a shift in understanding both the nature of and the origins of intelligence. The old view considers intelligence as a one dimensional trait of an individual transmitted genetically as "potential" for learning and adapting to the environment. The new view considers that intelligence is multifaceted and acquired through the automatic operations of the genetically transmitted

human cognitive system. This system includes innately given "knowledge" in the form of brain structures and functions that "remember" the physical environment of the parents and produce sensory systems that construct perceptual knowledge (hearing sounds; seeing scenes) through their automatic functioning in the womb and later, after birth, in the physical environment. From this point of view, cognitive ability, in the form of content in long term memory and information processing in working memory are characteristics of the human infant even before birth. But the contents of the memory system are not known to consciousness. The acquisition of control over mental processes and innately given knowledge develops after birth and results largely from interactions with the physical environment. Among the latter, the most significant interactions for the development of intellectual ability are those that the newborn has with other people, most often the parents, and especially the mother, but also including other caregivers.[10,39,44]

The "nature" versus "nurture" argument. Up until the middle of the 20th century intelligence had been thought of by many as largely biologically predetermined. The "amount" of intelligence an individual had was believed to be present at birth and to remain the same regardless of personal experience or formal training.[17]

Another perspective, however, which argued that intelligence is due to experience and is malleable, had been proposed as early as the 17th century. These opposing points of view constitute a classic argument about intelligence that is known as the "nature vs.nurture" debate. Is intelligence a biologically (nature) determined, innate potential or is intelligence an environmentally (nurture) determined, acquired potential? [17]

In the early decades of the twentieth century, the prevailing view was that it was intelligence that offered people their potential for learning and success. Since intelligence, and hence potential, was inherited there was not much one could do for those of low intelligence. They were best put into protective custody and prevented from reproducing .

However, by the early 1950s the views regarding intelligence had shifted from the "nature" side to the "nurture" side of the argument.[17] Arguments were now put forth that intelligence was not genetically determined, but, rather, was due to the nature of the person's experience.[12] It was argued that intelligence was malleable in early childhood, but that it reached about eighty percent of its adult level by age five or so.[11] Hence, the groundwork was in place for the War on Poverty's emphasis on early childhood interventions to improve the intelligence of children from improvished environments.

During this time, intelligence was still considered as primarily a unitary trait that a person acquired just so much of through experience. The operational measure of intelligence was the "Intelligence Quotient - IQ ." A single number that ranked the person's intelligence in relation to a norming group at each age level.

The developmental theory of Jean Piaget. A developmental model that tempered the strict environmentalist view of learning also became influential during the early 1950s and continues in influence today. Jean Piaget's theory is significant in at least two respects. First, it bridges both the "nature" and "nurture" sides of the intelligence debate and argues that biologically given intellectual structures unfold, much as embryological structures unfold, when thrust into a nurturing environment. Second, he proposes four mechanisms of cognitive development (maturation, experience, social transmission, and equilibration) through which the environment interacts with internal structures of the individual.

While Piaget's theory provides a conceptualization that allows a greater understanding of the structure and progression of cognition, his work does not address the role of knowledge in producing intellectual ability. Indeed, his theory predicts the same sequence of intellectual development as the person matures and experiences the world regardless of the particular nature of the knowledge domains encountered. Furthermore, it predicts that if a person reaches a given level of intellectual development , he or she is at that level in all domains of knowledge. But this is a prediction that has been disproven several times.[39]

Piaget's theory does not extend into adulthood. As in the case of conceptions of intelligence undergirding the early childhood programs of the War on Poverty, Piaget's conceptions of the development of cognition stress the malleabilty of intellect during childhood, not throughtout the lifespan. Nor does Piaget's theory of intellectual development directly address the intergenerational transfer of cognitive skills. In his theory, the individual is the focus and the role of social influence is merely to facilitate the automatic unfolding of biological, cognitive structures. However, his work did underscore the potential that was available to all children with the proper life events to bring it about.[39]

In the late 1950s and early 1960s, this new understanding of cognitive ability based on the influence of environment plus the developmental theory of Piaget provided hope for a better future for all, and offered an acceptable explanation for the correlation between minority group status, poor school achievement, and poverty. The presumed connection between minority group status and poverty was poor environment. Pursuing this theoretical perspective, the government implemented a number of social programs designed to improve the early environments of "disadvantaged" youth. As noted in Chapter 3, the results were not all that it was hoped they would be. It has been suggested that part of the reason for these results was the understanding of human intelligence in place at the time.[39,44]

A New Perspective: The Social Basis of Mind

Most discussions of the "nature and nurture" of human intelligence or cognitive abilities have focused on the innate capacities transmitted to the individual at birth as establishing the person's "potential" for cognitive development in interaction with the environment. This "interactionist" view of intelligence starts with the individual and attempts to determine the important factors that influence the individual's cognitive development.

A sociocultural view of cognitive development. A newer view of cognitive ability does not start with the biology of the individual or with the environment, but, rather, with the culture and society into which the individual is born. While genetics provides the anatomical structures and physiological functions that make the individual capable of cognition, and the physical environment (nutrition; gravity; light; structures such as trees, etc.) makes possible existence as a functioning biological organism, society and culture provide the most important resources for human cognitive development. These resources include symbols and symbol systems, such as the natural language and conceptual (in contrast to perceptual) knowledge, which consitute the primary means for the transmission of cognitive abilities. Very importantly, social groups direct the person's cognitive development through the value placed on the learning of certain skills, thereby providing the all important motivation for engaging in learning and behavior that lead to an individual's cognitive development beyond that resulting from untutored experience in the

world.In this view, the society and culture provide the context into which the individual begins his or her experience. The raw materials mentioned before are all present without the intervention of society, of course - the planets and trees and colors and gravity - but they would make no sense to the individual without the teaching of others. Societies possess language and communication and the other tools for comprehending, explaining, thinking about, and elaborating upon all of human experience. So, while previous views of cognitive ability suggest that there is some sort of innate potential that exists within an individual, another view would suggest that there is potential within the sociocultural context for development of the individual. The individual is born into a society of potential intellect. Knowledge will develop largely based on the evolution of intellect within the society and culture.

The social nature of mind. The sociocultural view of cognitive ability was advanced in the early 1900s and has recently regained interest among cognitive scientists as social constructivism and contextualism has emerged.[39,45,59,60] The sociocultural theory of cognition attempts to explain the cognitive development of the species and social groups (cultures) as well as individual development. In this theory, all higher psychological functions exist first and foremost in the interaction between individuals. Initially, the child has no way of understanding or communicating his or her experiences. It is through the teaching of parents and other members of the community that children come to understand the world they inhabit. Of course, the knowledge and values that caregivers have to pass on to their offspring reflect their particular social and cultural groups. Hence, the cognitive skills that the individual will develop incorporate the knowedge and ways of thinking of the culture into which she or he is born.

Language and cognition. The cognitive tools of the culture form a significant share of the knowledge transmitted as cognitive ability. These tools include, among other things, language and organized bodies of knowledge. Of these, language is the cornerstone of society. By learning the language, the child is introduced to the shared knowledge of the community. Parents, no matter what their socioeconomic or educational level, interpret the world for their children. Early learning takes place through the internalization of this interpretation of the world. Later, after the internalization of the ideas of the parents and society, children begin to use the language internally to guide their thinking and to function independently. Language, including the written languge in literate groups, is the unifying tool for the culture. As language is developed, so are social norms, cultural beliefs and values. [40]

Motivation and the value of learning. It has been argued that cognitive ability alone cannot account for achievement.[76] In addition to language and other cognitive tools transmitted to new members of society, there are important motivational conditions transmitted as well. These motivational states help to determine the level of achievement by community members. Cognitive sociologists have referred to the motivational aspect of social communities as social capital.[70] People learn information that corresponds to their view of the world - and they learn skills that will be meaningful to them. Children who are born into poverty and unemployment may not see the value of formal education, much less the learning of calculus.They may not think that it makes any difference to them. As adults, they are likely to pass on similar beliefs and attitudes to their offspring.[7,48,70]

In addition to messages about the value of learning, people also receive messages that help them determine whether or not they are capable of learning. They learn well, or not, depending on their view of their own ability to learn. An example of this motivational condition is the way the culture responds to failure and errors. There are culturally transmitted attitudes about the probability of learning successfully after one has initially failed to learn. These attitudes can greatly affect future learning. [76]

The individual within the group. From this perspective, the importance of the social and cultural niche on the development of cognitive ability in the individual can be seen. The broad features of the society, such as the technologies it possesses and the sophistication of the language, and the values placed on certain abilities such as mathematics can be predicted to largely determine the potential of the individual.These broad features will be interpreted through the local community, and will influence the extent or direction of development. Therefore, noncognitive aspects of the environment such as motivation are important as well and strongly influence the degree to which individuals will achieve.

But it is not the social environment alone that determines development. The individual and the way in which all of these experiences are interpreted, will make the rest of the difference. Cognition occurs within the context of a "mental model" that is built by the individual in response to experience in the world. This mental context both results from and results in the individual's unique cognitive development.

In spite of sociocultural similarities for a group of individuals living together, there are often huge differences in the ways in which these individuals develop. The culture of the individual, the community, the neighborhood, social organizations and the family will all influence the ideosyncratic experience of the world by the individual but the experience will be ideosyncratic. Because, just as pervasive as is the influence of the culture, it is just as true that each individual is unique. One often hears of comparisons made between individuals born in the same family who appear to have no real biological differences in learning ability but nevertheless achieve at much different levels. One of the explanations for this phenomenon is that no one ever experiences the world exactly the same as anyone else. As one behavioral geneticist has noted, there is frequently as much variability in intelligence within families as there is across the entire population.[79]

There are aspects of the culture that are shared by individuals and those that are not shared by individuals. It is these unshared aspects of the environment which have the most importance for individual differences. As noted, the variance in cognitive ability within families may be as great as that across families not sharing the same environment. By concentrating on mean differences bewteen large groups of people this important aspect of individual differences has been overlooked. To understand an individual's cognitive development, the context of the individual should be studied, including both the environmental (physical and social) context external to the person, and the internal context of the person's "mental model." While this greatly complicates the study of human cognition and its development, it is the only way to fully understand the growth of individual intellect.

New Directions for Future Interventions

There are several aspects of contemporary concepts of cognition and its development that are different from earlier concepts and which offer new directions for intervention programs. First, the social basis of intellectual development focusses on the role of social interactions in the intergenerational transfer of cognitive ability. It emphasizes the need to develop the social captial needed to provide cutural knowledge and the values needed to sustain the learning of such knowledge.

Second, there is a new appreciation of the role of content knowledge in cognitive ability. There is an old saying, "you gotta' know somethun' to learn somethun." It is vast bodies of knowledge that appear to give people the edge on learning more and more efficiently. From this perspective, earlier attempts to improve "intelligence" as a unidimensional "trait", or even achievement in "reading" as a pure processing skill, independent of the content being processed, appear inappropriate. The development of human capital requires greater attention to the role of content knowledge in cognition.

The concept of a human cognitive system implies a more analytic approach to cognitive development than the unitary trait conception of intelligence, one that addresses information processing within the cognitive system. Detailed cognitive task analyses reveal the interweaving of contexts, tasks, knowledge, and information processing by a person or groups of people involved in socially organized activities. The complexity of the interactions of these aspects of cognitive task performance suggests that much more attention should be given to teaching within the functional contexts in which we expect people to become active. This not only facilitates learning, it also facilitates transfer of learning to operational settings.

Finally, the new understanding of the role of specific knowledge, functional contexts, and social interactions in cognition suggests that cognitive development can be considered as a lifelong activity. New knowledge acquired in workplaces, during vacation travel, and so forth all contribute to the cognitive ability of the person. Because such experiences tend to be more varied than the school-based experencies of children, adults are likely to develop more varied cognitive ability. This makes it difficult to make uniform, universally suitable assessments of cognitive development in adulthood. This is a challenge for assessment.

Several implications for educational interventions of this new point of view regarding cognition and its development are given in Chapter 2. Chapter 5 considers major themes drawn from this social-intergenerational understanding of cognition and presents explicit recommendations for new directions for **making the nation smarter**.

Chapter 5

Future Directions

In this chapter we present recommendations for future directions for educational policy, practice and research that reflect our understandings of educational interventions and cognitive science reviewed earlier.

Three general themes that were revealed in the review and analysis of prior programs and research on cognitive science are woven throughout the following recommendations. These themes include (1) a need to attend to the cross generational consequences of programs; (2) a need to attend to the social nature of cognitive development, including motivation to learn, the contents of learning, and the manner in which different cognitive abilities are developed and distributed among social groups; and (3) a need to attend to the contexts in which programs are implemented and evaluated.

Factors of importance to the development of cognitive abilities that are not included in the following discussion are the need for a good prenatal environment, rich in nutrition and free from trauma, whether accident, disease, or drug-induced. Additionally, this report does not deal with overcoming biological or physiological problems that might retard the development of cognitive ability. While these are important factors to be considered in the development of cognitive abilities, they are beyond the scope of the present project.

Policy

Develop approaches to cognitive development that give more attention to the role of non-school, social networks.

o Address the need for community action programs that emphasize the development of "social capital" that can enhance school attendance.

o Develop community agencies that focus on the improvement of cognitive abilities in and out of school, with a major focus on out-of-school,community-based activities (home, community, work).

o Build on existing social networks (clubs; gangs; sports associations; hobby groups; etc) to develop interest in education and the development of cognitive abilities in the contexts of social activities in the particular setting.

o Expand involvement of families in educational activities. Promote greater use of Chapter I, Head Start, JTPA, and other funds for joint parent and child education.Consider adding parent's educational levels to criteria for eligibility of special funds (e.g., compensatory education funds).

Develop approaches to cognitive development that give more attention to the role of environments in cognitive development.

o Provide guidance for grocery stores, museums, gas stations, other businesses, highway departments, and other organizations that affect the information displays in the environment on how to make displays that develop cognitive abilities (particularly information and knowledge).

o Promote more effective use of television in cognitive development across the lifespan. Provide special inducements for activities such as the CBS/Library of Congress ***Read More About It*** trailers that guide viewers to books. Involve the advertising industry in cognitive development that is socially responsible.

Develop approaches to cognitive development that build on the strengths of diversity and pluralism in the United States.

o Promote greater appreciation for and development of bilingualism and multicultural knowledge as a key tool for relating to other nations and cultures in the interest of helping the United States compete more effectively in the international marketplace. Emphasize the cognitive abilities involved in bilingualism and multicultural knowledge, and the value of such abilities to the United States as a member of the world community. Build on linguistic and cultural diversity as a strength in the overall cognitive ability of the United States.

Improving the relationships among policy, practice, and research and the improvement of cognitive abilities.

o Policies need to be implemented that will improve the mutual understanding of policy makers, researchers, and practitioners. Today there is too much separation among these groups. This impedes the work of each. Projects are needed that encourage greater interactions among these groups. Most useful would be projects in which members of these different groups could serve in one of the other roles, such as when a researcher serves as a staff member for a congressman or other policy maker. Other types of internships, exchanges, or visiting appointments should be encouraged to improve the working relationships among these groups.

Practice

Focus on functional context education.

Instruction should be organized around the use of the information that is being presented. Basic skills should be taught within the context of important context. Students can be taught arithmatic while they are learning about consumer issues, science or other important topics. Reading can be taught while learning social studies, mathematics, and other content areas. In general, integration of content and skill learning should be encouraged.

- o The education of educators can include the idea of functional contexts and the usefulness of teaching students within the contexts of content information. This would be a change in thinking for many schools of education. New programs should be developed for teacher training that reflect a cognitive science perspective and the functional context approach to education.

- o Textbook materials for children should be updated to reflect the functional context approach. Children's textbooks can combine basic skills with the content being taught at the age level. Workbooks can be created which help the student practice the basic skills while learning the content.

Capitalize upon the social nature of learning.

Research on the effectiveness of cooperative learning in helping students master new ideas has suggested that many students learning in pairs can learn and retain new information better than they can alone.

- o Encourage the use of cooperative learning in the classrooms. Many classroom projects and practice sessions can be structured to include the use of cooperative learning.

- o Teacher training should include methods in the use of cooperative learning. Workshops and videos can provide information on the use of cooperative learning within different content areas for different age-group children.

- o Parents should be educated on the effectiveness of cooperative learning and the social nature of learning in general. Homework can be made a more effective social occasion if parents understand that learning together can result in good learning if the learning session is structured correctly.

- o Computer networks can bring together learners of all ages and promote within and across generation learning.

Programs should be developed to teach parents, teachers, and students about motivation.

o Parents can be educated in motivation by the media, by books and by television programs. PTA meetings can be used to present this type of parenting information.

o Educators need information about motivation and how best to raise motivational levels. Workshops and videos provide two good means for getting this information across. Teacher training textbooks can also incorporate this information. Schools of education need to incorporate the newer thinking of motivation into their curriculum.

o Many students worry excessively about performance - and ironically, their performance may suffer. Approaches that teach team problem solving or other cooperative, social learning methods may permit students to overcome their anxiety about performance and improve their work.

Research

Focus on the intergenerational transfer of cognitive ability.

Most research on the development of cognitive abilities of children or adults has focussed on methods for improving learning of a given individual or group of individuals under specfied conditions. This includes research on teaching methods, classroom management and so forth.

o Research needs to be addressed to the better understanding of the intergenerational transfer of cognitive abilities more broadly. For instance, how does the education of parents transfer to children? How do programs such as the Job Corps, Job Training Partnership Act (JTPA) programs, adult literacy programs, and so forth affect the cognitive ability development of the adult and the adult's children? What explicit information that adults possess gets transferred? How does this affect the child's knowledge development? In general,there is a great need for understanding the development of cognition as a social activity across generations.

o How can programs or other types of activities be developed that will improve cognitive abilities across generations? What should the goals of such programs be? Improved academic achievement? Improved out-of-school competence in some areas of practical concern, e.g., shopping, budgeting, avoidance of criminal behavior, or other indicators of social cognition (competence)? Improved productivity at work? Improved international competitiveness?

Research projects targeted for specific populations.

Too often research findings have been inappropriately generalized to populations in different geographical locations, of different ethnic and/or language background, or other contextual differences.

o Action research projects are needed that bring about cognitive development in populations well specified in regard to their contexts (geographical location; socio-economic status; language and cultural backgrounds; etc.). Research is needed in multiple sites, continued over long periods, in which the changes in context (e.g.,local attitudes toward divorce, pre-marital sex, etc.) are recorded and evaluated with respect to their influence on peoples' cognitive development. The research should involve researchers from different disciplines who can serve both as practitioners and as researchers. The need is for action research that can produce knowledge of cognitive development that is of high scientific quality and value. Most practitioners are either professionally unprepaired as cognitive scientists or too busy making programs work to be able to generate discipline-based knowledge. On the other hand, most cognitive scientists are too far removed from practice to grasp the development of cognitive abilities from a practitioners point of view. Action research projects are needed that can produce both improvements in cognitive abilities and cognitive science.

Conclusions

Our study of past and ongoing intervention programs leads us to suggest that large gains in cognitive development will be difficult, if not impossible,to achieve by simply expanding on current programs. Fortunately, however, knowledge gained from these programs and from contemporary cognitive science suggests to us that new approaches to improving cognition are possible. Many of these approaches can lead to **"double duty dollars,"** hence making it possible to achieve more cognitive growth within present or only slightly larger funding levels. Overall then, there is cause for optimism that future programs can be developed to meet the challenge of **making the nation smarter**.

Footnotes

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Appendix

A Conference on the **Intergenerational Transfer of Cognitive Skills** was held in April of 1988 in San Diego, California. Papers prepared for the conference will be published in 1989 by Ablex Publishers. The Table of Contents for the volume is given in this appendix.

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